ACTA PARASITOLOGICA POLONICA

VOL. VII WARSZAWA 15.IX.1959 FASC. 27

Department of Parasitology, University of Warszawa
Head of Department: Prof. Dr. Wincenty L. Wiśniewski

Leokadia JARECKA

On the life-cycle of *Bothriocephalus claviceps* (Goeze, 1782)

Wynik badania cyklu rozwojowego *Bothriocephalus claviceps* (Goeze, 1782)

When investigating the development cycles of tapeworms from birds and fish of Lakes Gołdapiwo and Mamry Północne between 1954 and 1958 (Jarecka, 1956, 1958) I collected materials concerning the development cycle of a tapeworm from *Anguilla anguilla* (L.) — *Bothriocephalus claviceps* (Goeze, 1782).

In the naturally invaded crustaceans caught in the littoral of both these lakes I discovered procercoids which I then identified with the *B. claviceps* procercoids I had obtained experimentally. In natural invasion the procercoids occured in *Macrocyclops albidus* (Jur.) only*.

I used eggs from live tapeworms from *Anguilla anguilla* intestine for the experiments. A live tapeworm, when taken out of intestine, ejects all eggs from its uterus into the water. The freshly ejected eggs have the property of adhering to the walls of glass, plants and other objects in water. The eggs have an operculum at one of the ends, are oval and their size is 59 × 36 μ.

I kept eggs free from impurities in pure lake water in a flatbottomed glass. The hatching of eggs occured on 5th or 6th day of the culture. It was spontaneous and the operculum of all eggs opened within one or two days.

* Methods of investigating the natural invasion of crustaceans at the lakes in question as well as quantitative and qualitative lists of the materials examined are presented in a previous publication (Jarecka, 1958) and another paper which is now being prepared by the present author.

The coracidia swim in the water from one to one and a half day. Unless eaten up by *Copepoda* they undergo gradual vacuolization, lose their mobil power, sink to the bottom and die in that time.

The *B. claviceps* coracidia do not in principle differ from the *Bothriocephalus scorpii* (Müller, 1776) ones described by Markowski in 1935. Inside a ciliated sphere there is an oncosphere with three pairs of embryonal hooks. I noticed no long bundle of cilia. When freshly hatched the coracidia are smaller than those which have sunk to the bottom and they are 59 × 59 μ and 83 × 83 μ respectively. A cone-shaped oncosphere is 27 × 36 μ and the embryonal hooks are 10 μ long.

In order to determine the first intermediate host I put newly hatched coracidia into previously prepared one-species cultures of various *Copepoda* species typically occurring at the lakes in question. I paid particular attention to invasions of *Copepoda* species typical of the pelagial und littoral zones of those lakes. The investigations showed that typically littoral species were intermediate hosts of *B. claviceps* and *Macrocyclops albidus* was its principle host. The experiments were repeated several times both at Gołdapiwo and Mamry Północne, and Table I shows the joint results of the repeated invasions.

The observations made during the experiments showed that the coracidia were eaten up by all *Copepoda* species used for the experiment, yet in such pelagial species as *Cyclops scutifer* and *Eudiaptomus graciloides* their oncospheres were digested. Only in *Mesocyclops leuckarti* did many larvae get into body cavity but found no favourable conditions for growth and development there. The larvae failed to develop into procercoids in the body cavity of *Mesocyclops leuckarti* within a month and became two or three times as large as the oncospheres. When sqeezed out of the cyclops body cavity all the larvae then examined were alive and mobile. I saw no larva die or degenerate in the cyclops body cavity.

In the body cavity of four littoral *Copepoda* species there were already well- developed procercoids on the 10th to 12th day of invasion. The extensity and intensity of procercoid invasion show that *Macrocyclops albidus* is the main experimental intermediate host of *B. claviceps*. Each of the invaded *M. albidus* contained anything between 5 and 20 well-developed procercoids on the 10th to 12th day.

The experimentally obtained procercoids of *B. claviceps* did not differ from those found in natural invasion. I found 7 *Macrocyclops al-*

bidus invaded by *B. claviceps* procercoids in my materials from Lake Gołdapiwo and 4 in those from Lake Mamry Północne. Single procercoids occurred in the body cavity in natural invasion.

Table I

Copepoda species	Invaded	No. of experiments	Extensity of invasion	Intensity of invasion
1. *Eudiaptomus graciloides* Lill.	500	3	0	0
2. *Cyclops scutifer* Sars	150	3	0	0
3. *Mesocyclops leuckarti* Claus	60	3	0	0
4. *Macrocyclops albidus* (Jur.)	500	5	100	5—20
5. *Macrocyclops fuscus* (Jur.)	60	2	45	1
6. *Acanthocyclops viridis* (Jur.)	90	3	0	0
7. *Eucyclops macruroides* (Lill.)	60	2	20	1
8. *Eucyclops macrurus* (Sars)	60	2	30	1

The above findings imply that *Macrocyclops albidus* is not only the main experimental intermediate host of *B. claviceps* but also plays this part in the natural conditions of those lakes. It is noteworthy that Lake Gołdapiwo (as I was told by Kozicka, who has examined the invasion of fish at those lakes) abounded in *Anguilla anguilla* while Mamry Północne comparatively less so. Their invasion by *B. claviceps* was about the same.

The *B. claviceps* procercoid has an elongated body and a relatively large cercomer with embryonal hooks. The size of the whole body and that of the cercomer depend to some extent on the number of larvae developing in the cyclops body cavity. The body measurements of a single procercoid developing in the cyclops body cavity may amount to 660 × 142 μ, while its cercomer may be 264 × 82 μ. Procercoids developing in great congestion are smaller, their body measuring 270 × 85 μ and the cercomer 105 × 50 μ. In natural invasion the body measured 500 × 185 μ and the cercomer 270 × 90 μ.

The *B. claviceps* procercoid has no hairs or bristles such as occur in the front part of the body of other *Pseudophyllidea* species of the ge-

nera *Ligula, Dibothriocephalus*. The head part of the *C. claviceps* procercoid is in principle like the head and adult tapeworm. It is somewhat widened and shows traces of muscles arranged just as those in adult forms. I observed no distinct openings of the penetrative glands. The procercoid is very clear. There are large luminescent calcareous corpuscles along poorly outlined excretory canals on the sides of its body.

When removed from the *Macrocyclops albidus* body cavity *B. claviceps* procercoids keep alive for a few hours and move vigorously.

Following the further destinies of *B. claviceps* procercoids I made the following experiment. I fed three two-to-four-cm-long specimens of *Carassius carassius* L. and, separately, two-to-three-cm-long *Cyprinidae* fry on experimentally invaded *Macrocyclops albidus* on the 18th day from invasion. The cyclopes let into the aquarium were caught by the fish in it. To prevent the invaded cyclopes from being eaten up by the *Cyprinidae* fry only, I got my *Carassius carassius* invaded separately.

I examined the *Cyprinidae* fry on the 1st, 2nd, 5th and 14th days of invasion and in two months, and all three *Carassius carassius* only in two months. At that time neither the *Cyprinidae* fry nor *Carassius carassius* contained any larvae in the body cavity or the intestine, while numerous *B. claviceps* larvae (20 to 60 specimens) were found in the small intestine of the fry examined on the 1st to 14th days. As early as the first day those larvae had no cercomers. They moved vigorously among the pyloric processes of the intestine and did not penetrate into the body cavity. Yet their measurements did not change even after their 14 days' stay in the intestine of the fry. However they became more muscular, particularly in the head part. The body of the larvae lost the transparence of the procercoids before the small granules appeared in it. The large calcareous corpuscles disappeared.

Summary and interpretation of results

1) The results of the investigation into the experimental and natural invasion of *Copepoda* showed that the development cycle of *B. claviceps* takes place in the littoral zones of Lakes Gołdapiwo and Mamry Północne. The typically littoral species of *Copepoda* — *Macrocyclops albidus* (J u r.) is the first both experimental and natural intermediate host.

2) When removed from the intestine of its final host, a live *B. claviceps* throws all eggs from its uterus into the water. Such freshly thrown-out eggs have the property of adhering to plants and other objects in the water.

3) The hatching of the coracidia in experimental conditions takes place on the 5th or 6th day. It is not gradual but spontaneous.

4) The development of the procercoid in the intermediate host in experimental conditions takes 10 to 12 days.

5) During the examination period (from the 1st to 14 th day) the *B. claviceps* procercoids in the experimentally invaded *Cyprinidae* fry did not penetrate into the body cavity, but continued alive and mobile among the pyloric processes of the intestine. Those larvae lost their cercomers on the 1st day of invasion. I observed no growth of the larvae in the intestine of the fry.

6) Neither the *Cyprinidae* fry nor *Carassius carassius* showed any invasion when examined in two months.

7) The behaviour of the *B. claviceps* procercoids in the alimentary tract of the fry, the similarity of the front part of the procercoid to the head of the adult tapeworm and lack of a corresponding plerocercoidal larva in the natural invasion of the fish examined at the above mentioned lakes by K o z i c k a (in litteris), all make me suppose that no second intermediate host is necessary in the development cycle of *B. claviceps.*

While investigating the development cycle of *Bothriocephalus cuspidatus* C o o p e r, 1917, E s s e x (1928) believed that no second intermediate host occurred in that cycle. According to that author small fish get invaded directly by feeding on cyclopes and when serving themselves as food for larger fish pass this tapeworm on to them.

Although the result of my experiments on invasion of fish is not yet complete and calls for further observation it seems to confirm this life-cycle for *B. claviceps* as well. However I have no findings to confirm the presence in the development cycle of *B. claviceps* of a procercoidal larva parasitizing in the intestine of the second intermediate host as described by M a r k o w s k i, 1935 for *Bothriocephalus scorpii* (M ü l l e r, 1776).

Authoress' address:
Zakład Parazytologii Uniw. Warsz.
Warszawa, Krak. Przedmieście 26/28

LITERATURE

1. Essex E. H. — On the life-history of *Bothriocephalus cuspidatus* Cooper, 1917, a tapeworm of the wall eyed pike. Trans. Amer. Micr. Soc., 47, 1928.
2. Ginecinskaja T. A. — Žiznennye cikly i biologia ličinočnych stadij parazitičeskich červei ryb. Verlag der Leningrader Staatlichen Universität, 1958.
3. Jarecka L. — Larwy tasiemców w jeziorze Gołdapiwo (Note preliminaire). Wiadomości Parazytologiczne, 3, 1956.
4. Jarecka L. — *Cladocera* as the Intermediate Host of Certain Species of *Cestoda*. Life Cycle of *Anomotaenia ciliata* (Fuhrm., 1913) and *Hymenolepis furcifera* (Krabbe, 1869). Bull. Acad. Polon. des Sc. Cl. II, ser. des sc. biol., 6, 4, 1958.
5. Markowski S. — Über den Entwicklungszyklus von *Bothriocephalus scorpii* (Müller, 1776). Bull. Acad. Polon. des Sc. et des Lettr, ser. B, Sc. Natur., 1935.

STRESZCZENIE

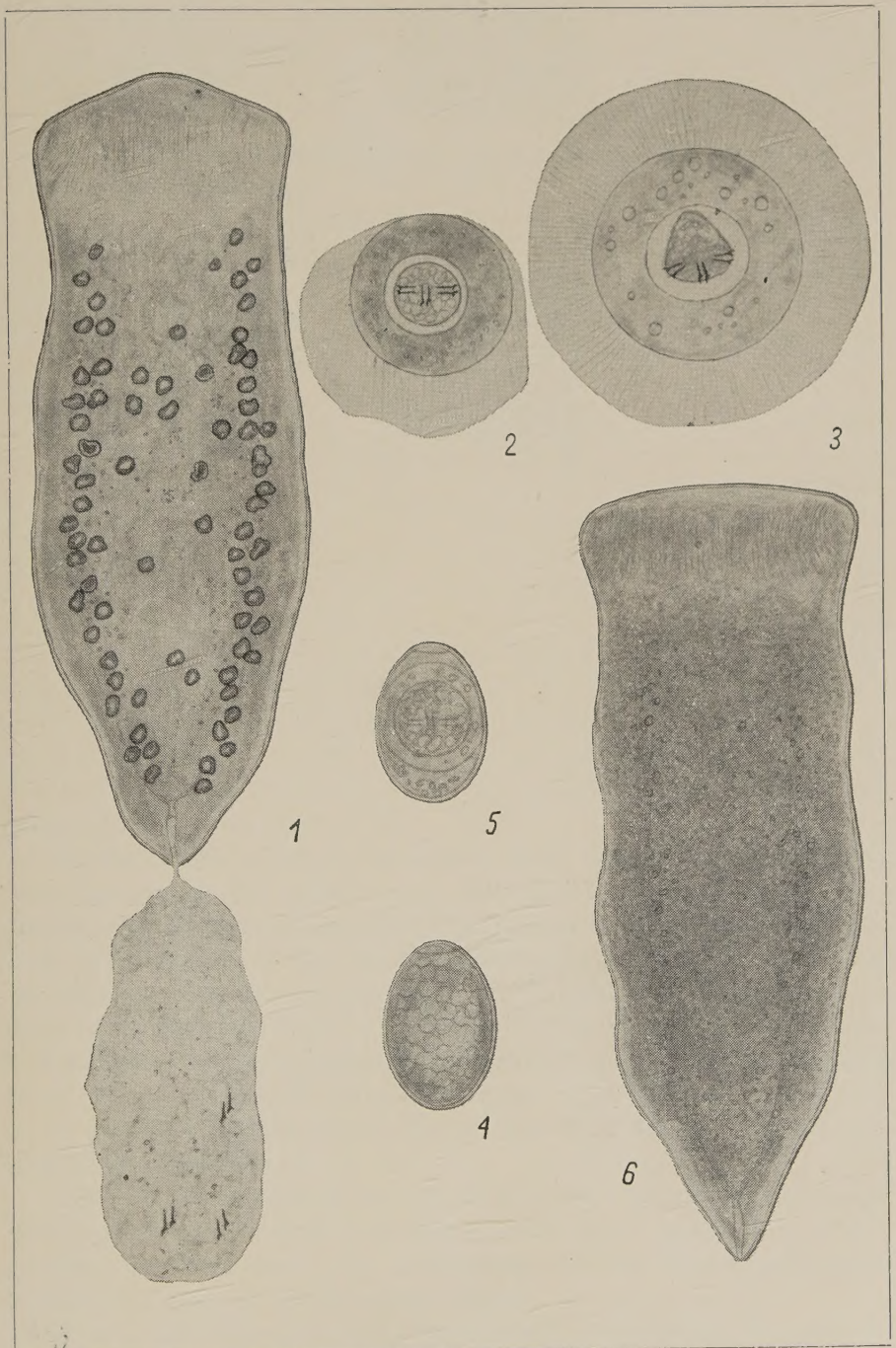
Autorka przedstawia dane dotyczące cyklu rozwojowego tasiemca z węgorza *Bothriocephalus claviceps* (Goeze, 1782).

Pierwszym żywicielem pośrednim, zarówno eksperymentalnym jak i naturalnym, okazał się typowo litoralny gatunek cyklopa *Macrocyclops albidus* (L.).

Procerkoidy *B. claviceps* w eksperymentalnie zarażonym narybku *Cyprinidae* w okresie badanym (od 1 do 14 dnia) nie przechodziły do jamy ciała, lecz pozostawały żywe i ruchliwe wśród wyrostków pylorycznych jelita. Narybek *Cyprinidae* oraz starsze *Carassius carassius* L., badane po upływie dwóch miesięcy, nie wykazały zarażenia larwami *B. claviceps*. Autorka przypuszcza, zgodnie z danymi z literatury dotyczącymi cyklów rozwojowych innych gatunków z rodzaju *Bothriocephalus*, że w cyklu rozwojowym *B. claviceps* nie występuje typowa postać plerocerkoida i w związku z tym nie jest konieczny drugi żywiciel pośredni. Według przypuszczeń autorki węgorz może się zarażać bezpośrednio, zjadając zarażone procerkoidami cyklopy bądź też małe ryby przechowujące przez pewien czas w jelicie larwy.

PLATE I

Fig. 1 — *B. claviceps* procercoid from *M. albidus* body cavity.
Fig. 2 — Newly hatched coracidium.
Fig. 3 — Coracidium sunk to bottom.
Fig. 4 — *B. claviceps* egg leaving uterus (first day).
Fig. 5 — Egg before hatching of coracidium (fifth day of culture).
Fig. 6 — *B. claviceps* larva in intestine of *Cyprinidae* fry (fourteenth day).



L. Jarecka auctor del.